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EFFECT OF COMPOST IN COMBINATION WITH PGPR ON GROWTH OF TOMATO *(LYCOPERSICON ESCULENTUM)* PLANT

SURENDRA KUMAR OJHA[1], JANE C. BENJAMIN[2] & AJAY KUMAR SINGH[3]

[1]*Student, Department of Microbiology and Fermentation Technology, SHIATS, Allahabad, Uttar Pradesh India*

[2,3]*Assistant Professor, Department of Microbiology and Fermentation technology, SHIATS, Allahabad, Uttar Pradesh India*

ABSTRACT

A pot experiment was conducted in the polyhouse of forestry to show the effect of compost and Pseudomonas fluorescens alone and in combination on growth of Lycopersicon esculentum. The growth parameters selected for study were Plant height, Root length, Number of leaves per plant, Number of fruits per plant and Weight of fruit. The results obtained during the course of investigation were further analyzed statistically. Effect of different treatment of compost and PGPR on growth of Lycopersicon esculentum showed maximum growth in terms of plant height, root length, number of leaves and number of fruits on using T_5 (combination of NPK, Compost and PGPR), as compared to other treatments .Finally it was revealed that dose of soil (1.5 kg) +NPK Recommended dose +Compost (1 kg) +PGPR treated soil was able to promote plant growth. Pseudomonas fluorescens (MCCB.0217) was shown to be a plant growth promoting agent for Lycopersicon esculentum. Hence, major research focus should be on the production of efficient and sustainable bio-fertilizers for crop plants, wherein inorganic fertilizer application can be reduced significantly to avoid further pollution problems.

KEYWORDS: Bio-Fertilizer, Compost, PGPR, Pseudomonas Fluorescens, Tomato

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Original Article

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) is the second most important remunerable solanaceous vegetable crop after potato With high nutritional value, it provides a balance source of Vitamin A, C and E needed to maintain good human health (**Chourasiya** *et al***., 2013)** The use of compost as a peat substitute to control root pathogens was first suggested by **Hoitink** *et al.* (**1975).** Since then, several soil-borne plant pathogens have been reduced by using composts made of different raw materials (**Hoitink and Fahy, 1986; Boehm, 1999**. The role of plant growth promoting bacteria (PGPB) have been extensively studied as bio-fertilizers to increase the yield of agronomically important crops such as wheat **(Khalid** *et al.,* **2004**) and corn **(Mehnaz and Lazarovits, 2006).** Beneficial effects of the introduction of specific microorganisms on plant growth have been reported for numerous crops, including tomato *(Lycopersicon esculentum Mill.*)

Pseudomonas fluorescens was used as a bio-control agent to manage bacterial wilt (**Liu** *et al.,* **1999**) and *Fusarium* wilt in Radish. In many studies it was observed that *Ralstonia solanacearum* mostly persists through soil and crop residues **(Granda and Sequira, 1983).** Therefore in view of the above facts the present study "Effect of compost in combination with PGPR on growth of tomato *(Lycopersicon esculentum)"* was conducted with the following objective:

- To formulate organic compost from Vegetables and agricultural wastes
- To determine the effect of compost in the presence and absence of selected PGPR on growth of Tomato plant

MATERIALS AND METHODS

Preparation of Bio-Fertilizer

The inoculum was prepared by inoculating rhizobacterial strain in 250 ml flasks containing DF minimal salt medium **(Dworkin and Foster, 1958**).The medium was incubated at 28 ± 1°C for 48 h in an orbital shaking incubator at 100 rpm. The optical density of inoculum was measured and a uniform population of rhizobacteria {(10^8 colony forming units) (CFU/ml=168* 10^8)} maintained at the time of inoculation. Plating of the bio-formulation was done on Nutrient Agar and plates were incubated at 37°C for 24 h. after incubation colony count was determined. Peat was ground and autoclaved at 121°C for 20 minutes. 100 ml inocula of the selected rhizobacteria was mixed with 100g of peat and incubated for 24 h at 28 ± 1°C before using for seed coating.

Seed Disinfection and Inoculation

For surface sterilization seeds were momentary dipped in ethanol (95%) and then in solution of $HgCl_2$ (0.2%) for 5 min and washed with Distilled Water. Then cell suspension of bacterial strain was mixed with seed and peat (1:1)

Pot Experiment

Pot experiment was conducted as per the given treatment.

Treatments Detail

Table 1

Treatments	Particulars
T_0	soil (2.5 kg)+Untreated seed
T_1	soil (1.5kg)+PGPR Treated seeds
T_2	soil(2.5kg)+Recommended dose of NPK+ Untreated Seeds
T_3	soil (2.5 kg)+compost (1kg)+ Untreated Seeds
T_4	soil (1.5 kg)+compost (1 kg) + PGPR Treated Seeds
T_5	soil(1.5 kg)+NPK Recommended dose+ Compost (1 kg)+PGPR Treated seeds

Total nutrient uptake of tomato plant is N 9.5, P 1.2, K 13.5 g (**Srinivasan, 2010)**

Growth Measurement of Plants

For each treatment, the plants of each pot were checked after the emergence of seedlings following characteristics of each plant were recorded after 15 DAS, 30 DAS, 45 DAS, 60 DAS, 75 DAS, 90 DAS (DAS –Days After Sowing):

- plant height
- Root length
- Number of leaves
- Number of fruit in plant
- Weight of fruit

Statistical Analysis

The data obtained during the course of work study was analyzed statistically using CRD design

RESULTS

Effect of Various Treatments of Compost and PGPR on Average Plant Height of Tomato

On analyzing effect of different treatment of compost and PGPR on plant height of *Lycopersicon esculentum* ,it was observed that maximum average plant height (in cm) as compared to control, was obtained in T_5 comprising combination of NPK, Compost and PGPR at 15 (7.267 cm), up to 90 (52.2)Days after sowing. Treatment T_4 (PGPR in combination with compost) showed the next best growth in terms of plant height from 7.1cm after 15 days after sowing up to 46.20 after 90 Days after sowing. Least growth in terms of plant height was seen in case of T_1 (T_1 as compared to control 15 days (6.300) up to 90days after sowing (23.13cm) as compared to control. On analyzing the data statistically the result was found significant. (Figure 1)

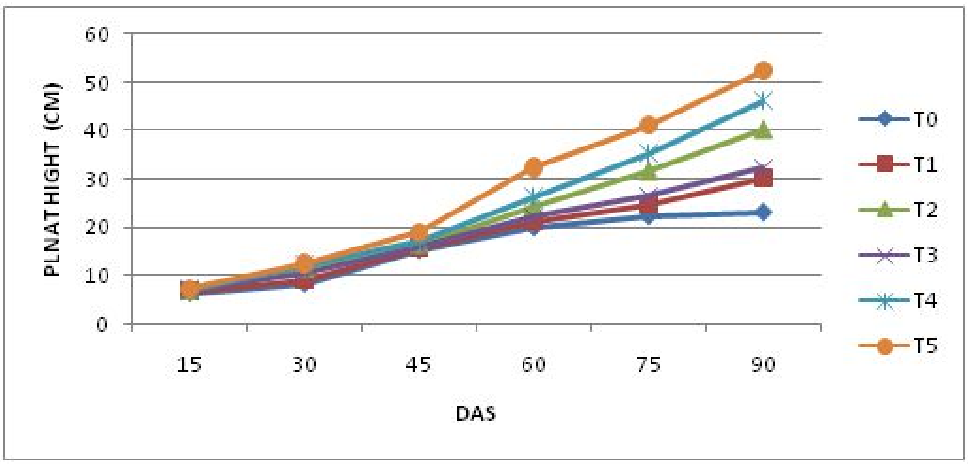

Figure 1: Effect of Various Treatments of Compost and PGPR on Plant Height of Tomato

Effect of Various Treatments of Compost and PGPR on Average Root Length of Tomato

Effect of treatment with compost, PGPR and NPK alone and in combination on *Lycopersicon esculentum,* showed that maximum average root length (in cm) as compared to control, was obtained in T_5 comprising combination of NPK, Compost and PGPR at 15 (3.433 cm), up to 90 Days after sowing(14.133 cm). This was followed by T_4 *i.e.* PGPR in combination with compost (3.233cm after 15 days after sowing up to 13.467 after 90 Days after sowing.) Least growth in terms of plant height as compared to control was seen in case of T_1 as compared to control 15 days (2.433) up to 90days after sowing (7.933). On analyzing the data statistically the result was found significant.(Figure2)

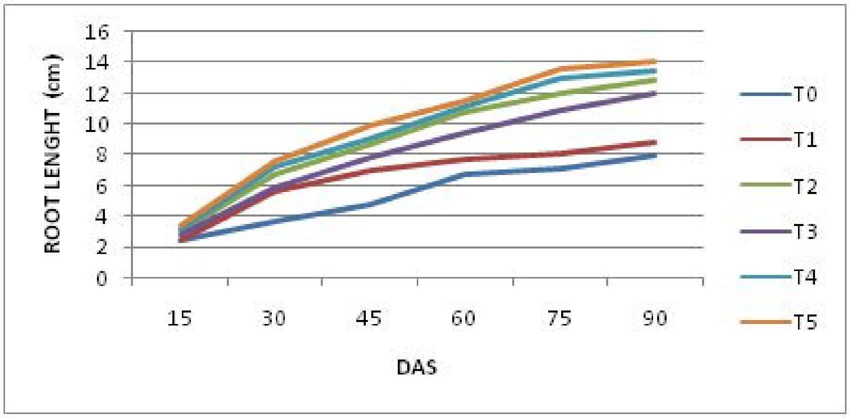

Figure 2: Effect of Various Treatments of Compost and PGPR on Average Root Length

Effect of Various Treatments of Compost and PGPR on Average Number of Leaves of Tomato

On analyzing effect of different treatment of compost and PGPR on number of leaves of *Lycopersicon esculentum,* it was observed that maximum average number leaves was obtained in T_5 comprising combination of NPK, Compost and PGPR at 15 (2.333), up to 90 Days after sowing (75.33). Treatment T_4 (PGPR in combination with compost) showed the second highest average number of leaves from 2.00 after 15 days after sowing up to 67.33 after 90 Days after sowing. Least average number of leaves was observed for T_1 as compared to control 15 days (1.667) up to 90days after sowing (35.33).The data on analyzing statistically was found significant (Figure 3).

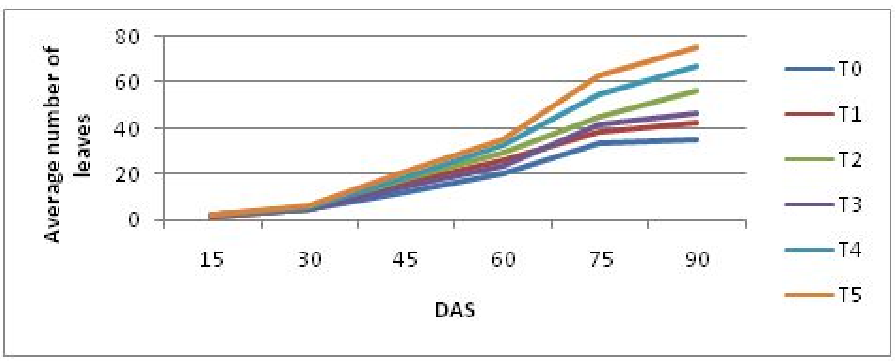

Figure 3: Effect of Various Treatments of Compost and PGPR on Average Number of Leaves

Effect of Various Treatments of Compost and PGPR on Average Number of Fruits of Tomato (*Lycopersicon esculentum)*

On analyzing effect of different treatment of compost and PGPR on number of fruits of *Lycopersicon esculentum,* it was observed that maximum average number of Fruits as compared to control, was obtained in T_5 comprising combination of NPK, Compost and PGPR at 75 (5 fruits), up to 90 Days after sowing (9.33). Treatment T_4 (PGPR in combination with compost) showed the next best growth in terms of average number of Fruits after 75 days after sowing up to (4.00) after 90 Days after sowing (7.33). Least Number of fruits were seen in case of T_3 (*i.e.* PGPR treated seeds) as compared to control. After 75 day after sowing average number of fruits were 1.33 and 90 days after sowing fruits it was 3.33. On analyzing the data statistically the result was found significant (Figure 4)

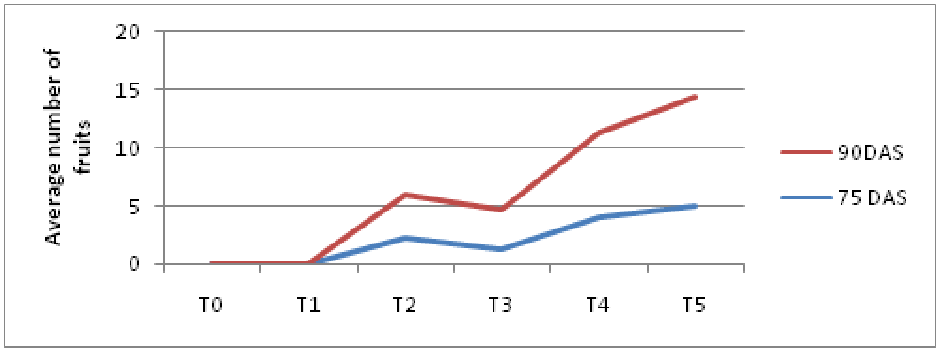

Figure 4: Effect of Various Treatments of Compost and PGPR on Average Number of Fruits

Effect of Various Treatments of Compost and PGPR Average Fruit Weight (in g) of Tomato (*Lycopersicon Esculentum*)

On analyzing effect of different treatment of compost and PGPR on fruit weight (in g) of *Lycopersicon esculentum,* I t was observed that maximum average fruit weight (in g.) as compared to control, was obtained in T_5 comprising combination of NPK, Compost and PGPR at 75 (38.66), up to 90 Days after sowing(53.33). Treatment T_4 (PGPR in combination with compost) showed the next best growth in terms of fruit wt (g) from 37.33 after 75 days after sowing up to 42.66 after 90 Days after sowing. Least growth in terms of fruit weight (in g) was seen in case of T_3 (*i.e.* PGPR treated seeds) as compared to control. On analyzing the data statistically the result was found significant. (Figure 5)

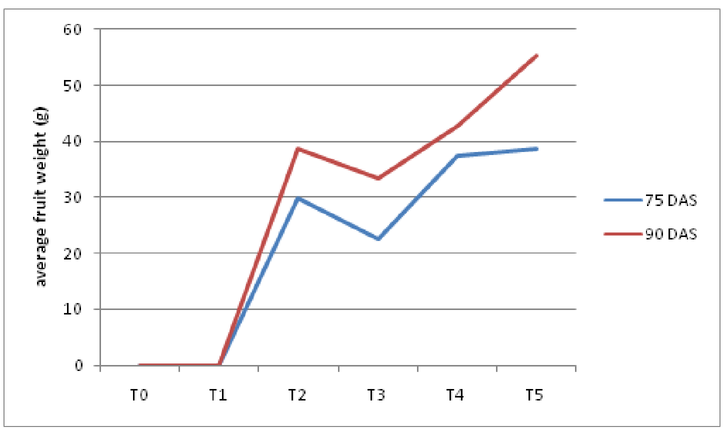

Figure 5: Effect of Various Treatments of Compost and PGPR on Average Fruit Weight (in g)

DISCUSSIONS

In agreement with the present investigation various studies have reported increased plant growth in terms of plant height (**Rahman** *et al.,***2012).** Similarly **Ali and Jahan (2001)** showed application of vermicompost with NPK to significantly increases plant growth of sesame and ladyfinger. Also **Rini and Sulochana (2006)** studied growth promotion in chilli to be more pronounced with *Trichoderma harizanum* and *Pseudomonas fluoresens* applied in conjunction. In a similar study **Ashrafi** *et al*., **(2010)** found application of organic manure and NPK to significantly affect plant height.

Inoculation of Marjoram plants with PGPR and compost at early stage of development results in positive impact on biomass production by improving soil physical and biological properties directly affecting plant growth. **Balakrishna** *et al*., **(2007)** found application of compost in combination with phosphate solubilizing bacteria to significantly increase soil enzyme activities as phosphatase. Also **Bama** *et al*., **(2008)** reported higher dehydrogenase value in soil amended with compost compound to soil fertilized with chemical fertilizers. In contrast, **Tsado (2015)** reported that height of tomato plant was not significantly different when various sources of compost was added. This may be attributed to animal waste being poorest in giving tomato plant height as animal based compost was low in nutrients and depended on animal feed.

In similar study PGPR change assimilate partitioning patterns in plants altering growth in roots **(Lucas** *et al.,* **2004)** *Pseudomonas fluoresens* have also demonstrated increased effect on development of tomato and cucumber root (**Gamalero** *et al*.**, 2002; Gamalero** *et al*.**, 2003)**. Longer root systems are more adapted to soil exploitation. **Cleyet** *et al.,(***2001)** found inoculants of plant with PGPRs at early stage of development resulting in positive impact on biomass production through direct effects on root growth.

Soil microorganism that colonize the rhizosphere assist plants in uptake of vital nutrients as P, K and N from soil (**Kennedy** *et al*., 2004). The increase in growth may be related to positive of compost and microorganisms in increasing the root surface area per unit of soil volume, water use efficiency and photosynthetic activity, which directly affects physiological processes and utilization of carbohydrate

In agreement to the present investigation **Ahirwar** *et al*. (**2015**) reported increased vegetation growth indicated by increased number of leaves.

Results of greenhouse study by **Mezuan** *et al.* **(2004)**also showed that application of biofertilizer formulation to rice plant increased number of Saplings. In addition **Jayathilake** *et al.(***2002)** found that in onion of leaves per plant were higest on treatment

Meena *et al.* **(2007)** demonstrated highest fruit and seed yield achieved through application of vermicompost combined with *Azotobacter*. Vermicompost application with bio-fertilizers (Phosphate solubilizing bacteria and *Azotobacter*) significantly enhanced yield attributes in then studies **Nag and Singha, (2008) Patel** *et al.(2010)*The significant increased in yield might be attributed to improved uptake of N, P and K from vermicompost as well as increased chlorophyll production in leaves **Tejada** *et al.(***2007**)

Vermicompost increase microbial population with production of plant-growth-influencing materials and build-up of plant resistance or tolerance to crop disease and nematode attack (**Arancon** *et al.,* **2006**). Moreover macronutrient play important role on enhancing yield based on their role in activation of enzyme for chlorophyll synthesis, growth, fruit ripening and maintenance of the plant's enzyme system (**Grusak and Della,** 1999).

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CONCLUSIONS

In conclusion, dose of soil (2.5 kg) + NPK Recommended dose +PGPR treated soil was able to promote maximum plant growth. *Pseudomonas fluorescens* (MCCB.0217) was shown to be a plant growth promoting agent for *Lycopersicon esculentum.*

Excess nutrients are accumulated in soil, particularly as a result of over application of chemical fertilizers by farmers during intensive agricultural practices. Hence, major research focus should be on the production of efficient and sustainable bio-fertilizers for crop plants, wherein inorganic fertilizer application can be reduced significantly to avoid further pollution problems. It will be necessary to undertake research in which soil microbiologists, agronomists, plant breeders, plant pathologists, and even nutritionists and economists must collaborate in order to select effective and competitive multi-functional bio-fertilizers for a variety of crops, design a quality control system for the production of inoculants and their application in the field, to ensure and explore the benefits of plants-microorganism symbiosis.

REFERENCES

1. ***Ahirwar, N.K., Gupta,G. ,Singh,V., Rawlley, R.K. and Ramana, S. (2015).*** *Influence on growth and fruit yield of tomato (Lycopersicon esculentum Mill.) plants by inoculation with Pseudomonas fluorescence (SS5): Possible role of plant growth promotion. International Journal of Current Microbiology and Applied Sciences .**4:** 720-730.*

2. ***Ali, M.S. and Jahan, M.S.(2001)***. *Final completion report on "Coordinate Project of Vermiculture: Production of Vermicompost and its use in Upland and Horticulture Crops." BARC, Dhaka. p. 21.*

3. ***Arancon, N.Q., Edwards, C. A. And Bierman, P.(2006)***. *Influences of Vermicomposts on Field Strawberris. Effects on soil Microbial and Chemical Properties. Bioresource Technology .**97:** 831-840.*

4. ***Ashrafi, R., Biswas, M.H.R., Rahman, G.K.M.M., Khatuna, R. and Islam, M.R. (2010).*** *Effect of Organic Manure on Nutrient Contents of Rice Grown in an Arsenic Contaminated Soil. Banglades Journal of Scientific Research. **45(3)**: 183-188.*

5. ***Balakrishna, V., Venkatesan, K. and Ravindran, K.C. (2007).*** *The influence of halophytic compost ,farmyard manuread phosphobacteria on soil microflora and enzyme activities .Plant Environment. **53(4)**: 186-192.*

6. ***Bama, S., Somasunder, K., Porpavai, S.S., Selvakumari, K.G. and Jayaraj, T.T.(2008).*** *Maintenance of soil quality parameters through humic acid application in an alfisal and inceptisol. Australian Journal of Basic Applied Sciences. **2:** 521-526.*

7. ***Chourasiya, P.K., Lal,A.A. and Simon, S.(2013).*** *Effect of certain fungicides and botanicals against early blight of Tomato caused by alternaria solani (ellis and martin) under Allahabad uttar pradesh, india conditions. International Journal of Agricultural. **3(3):** 151-156.*

8. ***Cleyet, M. J., Larcher, H., Bertrand ,H., Rapior, S. and Pinochet, X. (2001).*** *Plant growth enhancement by rhizobacteria. In: Morot- Gaudry, J.F. (ed.), Nitrogen Assimilation by Plants: Physiological, Biochemical and Molecular Aspects. **4(3)**: 185–99.*

9. ***Dworkin, M. and Foster, J.W. (1958).*** *Experiments with some microorganisms which utilize ethane and hydrogen. Journal of Bacteriology. **75(5):** 592–603.*

10. ***Gamalero, E., Martinotti, M.G., Trotta, A., Lemanceau, P. and Berta, G.(2002)."****Morphogenetic modifications induced by Pseudomonas fluorescens and Glomus mosseas in the root system of tomato differ according to plant growth condition .New Phytologist. **155:** 55-65.*

11. ***Gamalero, E., Fracchia, L., Cavaletto, M., Garbaya,J., Frey,P., Varese,G.C. and Martinotti,M.G.(2003)***.*"Characterization of functional traits of two fluorescent Psedomonads isolated from Basidiomes and Ectomycorrhizal fungi ". Soil biology and Biochemistry.**35:** 55-65.*

12. ***Granada, G.A. and Sequeira, L. (1983).*** *A new selective medium for Pseudomonas solanacearum. Plant Disease Journal. **67:** 1084–1088.*

13. ***Grusak, M.A. and Della, P. D. (1999).*** *Improving the Nutrient Composition of Plant to Enhance Human Nutrition and Health. Annual Review of Plant physiology and Plant Molecular Biology .**50:** 133-161*

14. ***Hoitink, H. A. J. and Fahy, P.C. (1986)***. *Basis for the control of soilborne plant pathogensW ith composts. Annual Review of Phytopathology.**4:** 93- 114.*

15. ***Hoitink, H.A.J., Schmitthener, A.F. and Herr, L.J. (1975***). *Composted bark for control of root rot in ornamentals. Ohio Report on research and Development. **60(2):** 25–26.*

16. ***Hoitink, H.A.J. and Boehm, M.J.(1999)***. *Biocontrol within the context of soil microbial communities a substrate-dependent phenomenon. Annual Review of Phytopathology. **37**: 427–446.*

17. ***Jayathilake, P.K.S., Reddy, D.,Srihari, G., N. and Reddy, R.(2002).*** *Effect of nutrent management on growth ,yield and yield attributed of rabi onion (Allium cepa). Journal of Vegetable Science. **29:** 184-185.*

18. ***Kennedy, I.R., Choudhury, A.I.M.A. and KecSkes, M.L. (2004).*** *Non-symbiotic bacterial diazotrophs in crop-farming systems: can their potential for plant growth promotion be better exploited. Soil Biology and Biochemistry. **36:** 1229–1244.*

19. ***Khalid, A., Arshad, M. and Moritz, T. (2004***). *Screening plant growth-promoting rhizobacteria for improving growth and yield of wheat. Journal of Applied Microbiology. **96:** 473-480.*

20. ***Liu, Q.G., Liz, T. Z. and Zeng, X. M. (1999***). *Control of tobacco bacterial wilt with antagonistic bacteria and soil amendments. Chinese Journal of Biological Control. **15:** 94–95.*

21. ***Lucas-Garcia, J.A., Probanza, A., Ramos, B., Ruiz., P. and Gutierrez –Manero,F.J.(2004)*** *" Effect of inoculation of Bacillus licheniformis on tomato and pepper". Agronimie. **24:** 169-176.*

22. ***Meena, O. Khafi, H.R., Seikh, M. A., Mehta, A.C. and Davda,B.K.(2007).*** *Effect of Vermicompost and Nitrogen on Content, Uptake and Yield of Rabi Maize, Journal of Crop Research, **33 (1,2 &3):** 53-54.*

23. ***Mehnaz, S. and Lazarovits, G. (2006).*** *Inoculation effects of Pseudomonas putida, Gluconacetobactor azotocaptans and Azospirillum lipoferum on corn plant growth under green house condition. Microbial Ecology. **51:** 326-335.*

24. ***Mezuan, V., Handayani, P. and Inoriah, E.(2004)***.*Application biofertilizer formulation for plant cultivation Rice. Emirates Journal of Food and Agriculture. **4:** 27—34.*

25. ***Nag, K. and Singha, A. K.(2008).*** *Residual Effect of Vermicompost, Chemical Fertilizer and Biofertilizer in Wheat (Triticum aestivum) on Succeeding Fodder Cowpea (Vigna unguiculata), Annals of Agricultural Research, **29 (1,2,3 &4):** 73-77.*

26. ***Patel, P. S., Kolambe, B. N., Patel, T. U. and Patel, H.M.(2010).*** *Effect of Different Organic Manures on Growth, yield, Nutrient Uptake and Soil Properties of Bananacv. Grand Nain, The Andhra Agricultural Journal. **57(3):** 316-319.*

27. ***Pozo, M. J., Cordier,C. E., Dumas, G. S., Gianinazzi, J. M., Barea, G. and Azcon, A. (2002).*** *Localized versus systemic effect of arbuscular mycorrhizal fungi on defense responses to Phytophthora infection in tomato plant. Journal of Experimental Botany **53:** 525-534.*

28. ***Rahman ,M.A, Rahman,M.M., Begumn,M.F.and Alam,M.F.(2012)**. Effect of bio compost, cow dung compost and NPK fertilizers on growth, yield and yield components of chili. International Journal of Biosciences. **2(1)**: 51-55.*

29. ***Rini, C.R. and Sulochana, K.K.(2006).** Management of seedling rot of chilli (Capsicum annuum L.) using Trichoderma spp. and fluorescent pseudomonads (Pseudomonas fluorescens). Journal of Tropical Agriculture. **44 (1-2):** 79-82.*

30. ***Shakya, D.D. (1993)**. Occurrence of Pseudomonas solanacearum in tomato seeds imported into Nepal. Bacterial Wilt. Australian Centre for International Agricultural Research. **45:** 371–372.*

31. ***Tejada, M., Gonzalez, J., Hernandez, M. and Garcia, C.(2007).** Agricultural use of leachates obtained from two Different vermirrecompost processes. Bioresource Technology. **99:** 6228-6232.*

32. ***Termorshuizen, A. J., Van, R., D. J., Van,D. G., Alabouvette, C., Chen, Y., Lagerlof, J., Malandrakis, A. A., Paplomatas, E. J., Ramert, B., Ryckeboer, J., Steinberg, Z.N.S. (2006).** Suppressiveness of composts against soil borne plant pathogens. Soil Biology and Biochemistry. 38: 2461-2477.*

33. ***Tsado, E. K. (2015**). The best source of compost for tomato production: a study of Tomato production in niger state, nigeria. Global Journal of Agricultural Research **3(4):** 23-33.*